

Workshop on CO₂ Mineralization Day One Recap

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Paths and Interests Possible Confusion

CO₂ Mineralization

***In Situ* Mineralization**

- Subterranean storage methods
- Ore body pretreatment
- Acceleration of rock dissolution rates
 - Catalysis
 - Water & pressure management

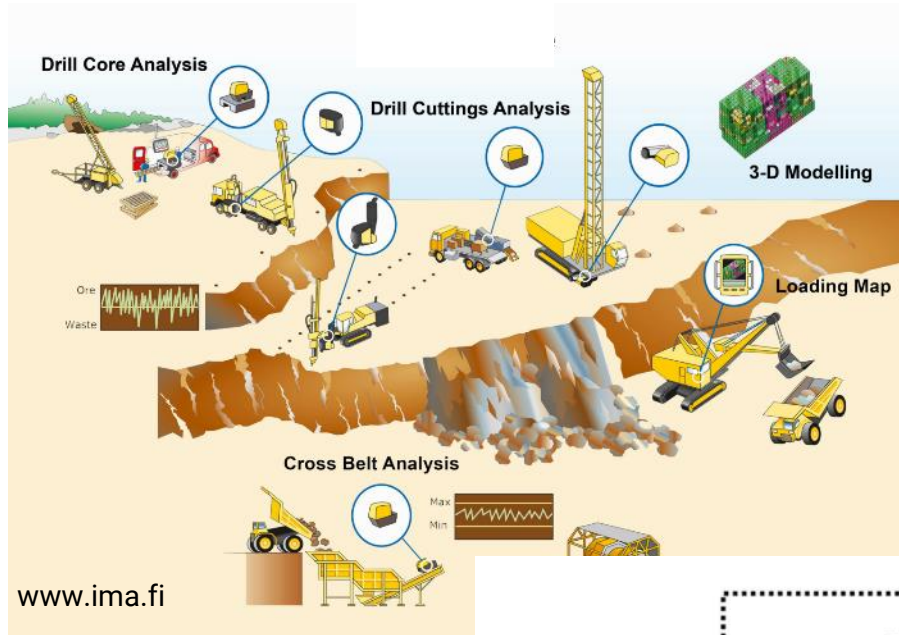
Mineralization w/ Extraction

- Reactive extraction from ore
- Active mineralization in tailings
- Redeployment of tailings

Common Ground

- Geology & petrology
- Identification and mapping
- Reaction chemistries
 - Thermochemical
 - Biochemical
- Metrology

For Mineral Extraction – 3 places to react with CO₂



During processing

- Comminution
- Flotation
- Extractive step



Pre-treatment

- Before extraction
- During extraction

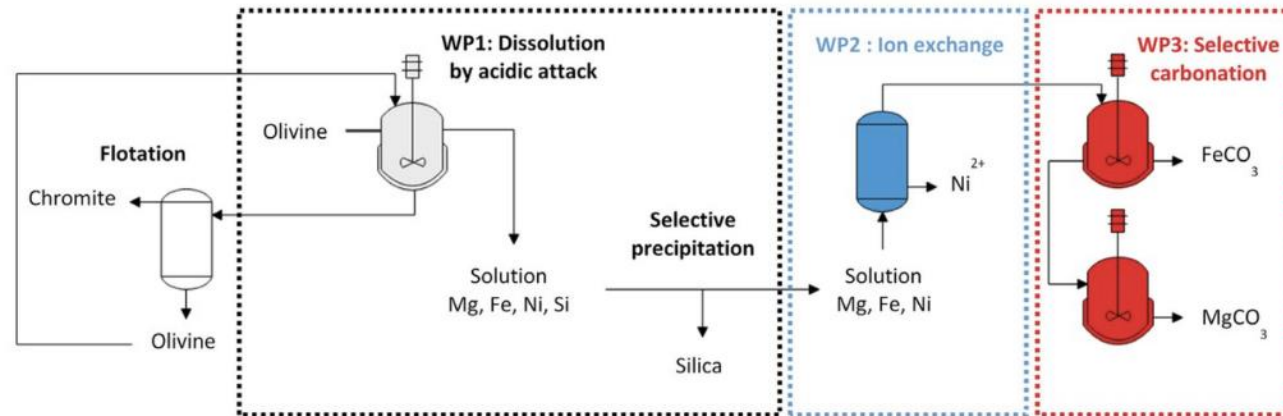


Figure 4

Schematic view of the process for CO₂ sequestration by indirect carbonation of olivine.

Post processing

- Before it the tailings pile
- Process residue
- Overburden

Desired Paths and Interests Clarification

CO₂ Mineralization

Path One – “Doug”

Path Two – “Joe”

Enhanced Metals' Extraction
via CO₂ Mineralization

Long-term Carbon Storage via
CO₂ Mineralization

2
During Normal Mining
Processing

in situ/Down Hole/Sub-surface

1

3

Pre-treatment

ex situ (surface) or *in situ* (sub-surface)

Post Processing or
Tailings

Note: The Type of reactive rock used will depend on the metals you're trying to extract.

Note: Any Type of reactive rock can be used since mineralization alone is the target.

Breakout Highlights

Chemical

- Supercritical CO₂ already used in oil & gas fields
- Pressure & fracking could accelerate *in situ* rates
- Weatherization is greatly improved by comminution.
- Passivation a concern but less so for basalts
- Insufficient detailed to model system properly
- True extraction value driven by which elements

Electrochemical

- Geology not known at sufficient detail: fouling by trace elements/impurities
- Most appropriate for low-concentration ores & tailings
- Lower purity CO₂ may foul electrodes.
- Processes may differ by ore type & concentration
- Most appropriate for *ex situ* and surficial sites
- Possible downhole chlor-alkali acceleration

Microbiological

- Conditions and cultures will be site specific
- Biofouling is a documented problem
- Bioremediation is the best place to draw inspiration.
- Limited understanding of downhole microbiome
- Numerous examples of microbiological acceleration
- Biological practices proven in the lab may be ineffective in the field

Phytomining

- Weatherization faster in Agri-environments
- Plant choice matters: e.g. legumes increase rate
- Mines in higher latitudes, hyper accumulators in tropical settings.
- Right combination of land use, geology & climate: avoid food vs. fuel debate
- Plant engineering could improve feasibility
- Scaling relevant plants is a years-long process

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